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GALL MIDGE FORMS GALLS ON FRUIT FLY GALLS (DIPTERA: CECIDOMYIIDAE, TEPHRITIDAE)

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Abstract.—A cecidomyiid gall midge, *Rhopalomyia bigeloviae* (Cockerell), was reared from galls formed on galls of the tephritid, *Aciurina trixa* Curran, on *Chrysothamnus nauseosus* (Pallas) Britton in southern California. Only one of the two *A. trixa* gall types in southern California hosted the gall midge. *Rhopalomyia bigeloviae* galls were originally discovered in Colorado on the large cottony galls of *A. bigeloviae,* a species closely related to *A. trixa,* that forms galls on *C. nauseosus* outside of California. The midge galls are similar to the host tephritid galls externally, i.e. either smooth or cottony. The number of midge galls per tephritid gall varies, but they can, in some cases, cover the entire surface of the tephritid gall. The gall midge is probably bivoltine, and the tephritid host is univoltine. Gall midge galls first become visible in early spring (March). Adults emerge later in the spring. The fate of these adults remains unknown, but females may oviposit into other parts of the host plant to form a second generation of cecidomyiid galls not dependent on the presence of a tephritid gall.

Key Words: Gall formers, gall midge, Cecidomyiidae, Tephritidae, *Aciurina, trixa, Rhopalomyia, bigeloviae*

Aciurina trixa Curran forms axillary bud galls on branches of its only known host plant, *Chrysothamnus nauseosus* (Pallen) Britton, in western United States; but, the morphology of its gall varies strikingly within its range. In Idaho, at least three gall morphs of *A. trixa* were reported by Wangberg (1981); in southern California, we recognize two gall morphs for *A. trixa* on *C. nauseosus* (Headrick et al. 1997).

On one of the two gall forms in southern California (Fig. 1A), we observed that its exterior sometimes was covered by small nodules at different densities among different locations. Upon dissection, each of these nodules was found to contain a small cecidomyiid identified for us as *Rhopalomyia bigeloviae* (Cockerell) by Raymond J. Gagné (Systematic Entomology Laboratory, Agricultural Research Service, USDA). This species was originally described from a large woolly gall up to 12 mm long, typical of that made by another species of *Aciurina* (Gagné 1986). Dodson and George (1986) and Headrick et al. (1997) have clarified the status of *Aciurina* species on *C. nauseosus,* and this woolly gall is now attributed to the tephritid, *A. bigeloviae* (Cockerell). We have examined such woolly galls from various collections (Washington State University, Pullman; University of Idaho, Moscow; G. Dodson, personal collection) and they do, indeed, bear *R. bigeloviae* galls. None of the other gall types, as described by Wangberg (1981), examined from museum collections throughout western U.S., including the smaller resinous gall of *A. trixa* found in California hosted this gall midge (Headrick et al. 1997).

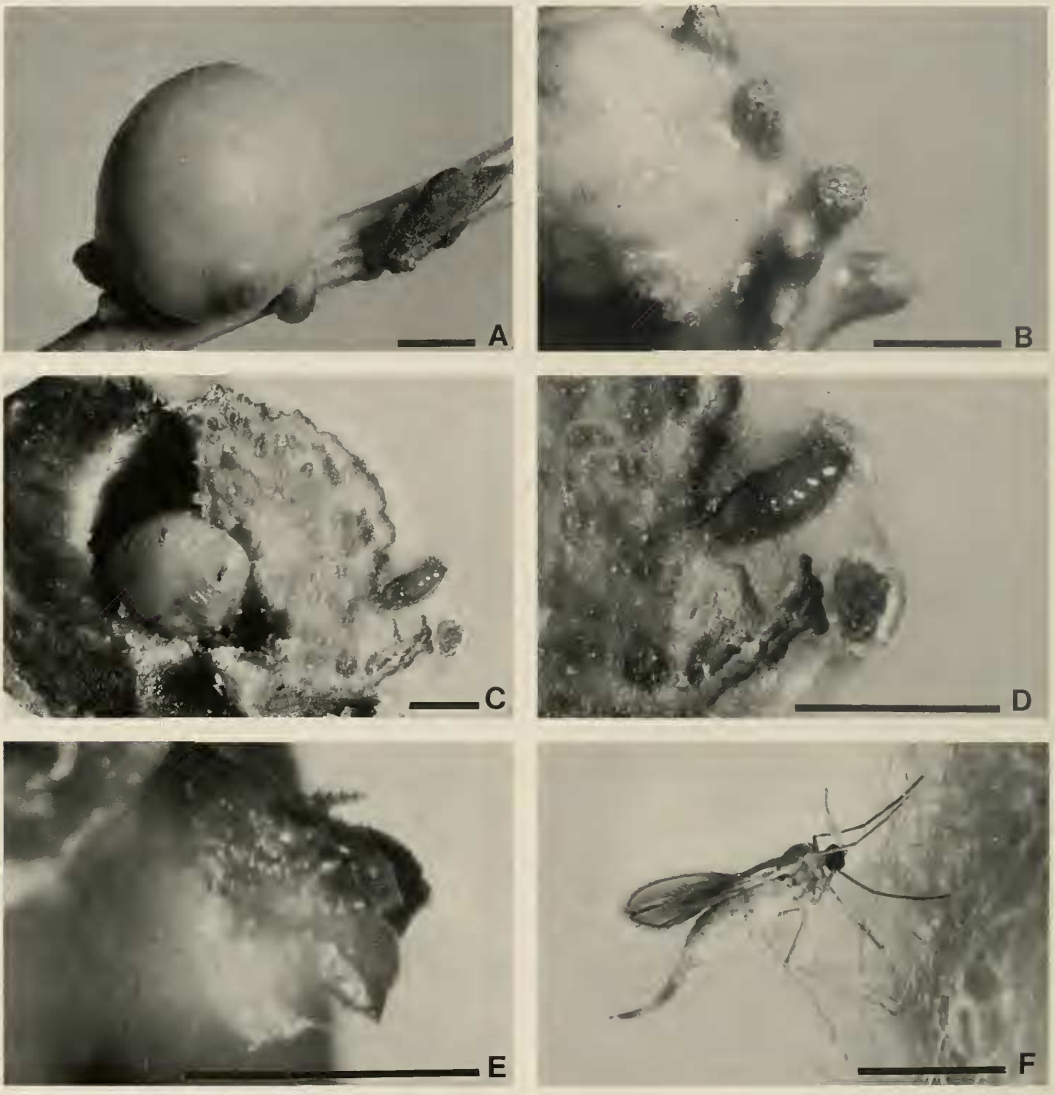

Fig. 1. (A) The fully formed gall of *Aciurina trixa* on *Chrysothamnus nauseosus*; (B) detail of the cecidomyiid, *Rhopalomyia bigeloviae,* galls on an *A. trixa* gall; (C) saggital section of *A. trixa* and *R. bigeloviae* galls; (D) detail of the *R. bigeloviae* gall with cecidomyiid larva within; (E) the exposed pupa of *R. bigeloviae*; (F) an adult female of *R. bigeloviae.*

In southern California, the midge galls become visible in early spring (March) and grow very rapidly (Fig. 1B), as do other *Rhopalomyia* spp. galls (Gagné 1989). The gall in saggital section is layered exactly like the tissues comprising the parent *A. trixa* gall, including the smooth, waxy, outer layer. On the cottony galls of *A. bigeloviae,* the midge galls also bear the thick tomentum of the host fruit fly gall, thus, the midge gall takes on the surface characteristics of the host gall. In southern California, the midge larvae feed within their gall locules as the tephritid larva continues to develop in its own, much larger, separate locule (Fig. 1 C, D). Midge development proceeds rapidly and both the tephritid and midge co-occur as late-instar larvae, and pupate at about the same time. The midge pupa forms inside its gall locule, but the

waxy apex of its gall sometimes splits, partly exposing the pupa within (Fig. E). The gall midge adult emerges in April (Fig. F), but the fate of this generation remains unknown. We know that *A. trixa* is univoltine on *C. nauseosus,* with the gall dying after emergence of the fruit fly adult. Thus, the current season's tephritid galls are no longer suitable for oviposition by the midge. The options for the adult female gall midge following emergence include, but are not restricted to, oviposition into the primordial tephritid gall tissues or the axillary bud galls of the host plant or oviposition on another part of the host plant, thus cycling between alternate gall types. The latter appears likely as this has been reported for other species in this genus (Gagné 1989). There is as yet no indication that the cecidomyiid affects the growth and development of the tephritid and the relationship thus appears unequal, with the cecidomyiid dependent on the tephritid during this part of its life cycle.

This is the first known description and illustration of a cecidomyiid gall being formed upon a tephritid gall. Tephritids are known to be inquilines of cecidomyiid galls (Jones et al. 1983), but this is the most intimate association between gall-forming flies of these two families known to us.

Some workers may not have previously recognized this phenomenon and interpreted the growths on tephritid galls as developing leaves (Fernandez and Price 1994). This does happen, but closer inspection may otherwise reveal not a budding leaf, but rather a developing cecidomyiid gall!

Dedication.—We would like to dedicate this paper to Raymond J. Gagné in honor of his recent retirement from the Systematic Entomology Laboratory, U.S. Department of Agriculture.

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